Volume 43 OCTOBER, 1957 *Number 10*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

CEMENT MILL LUBRICATION

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

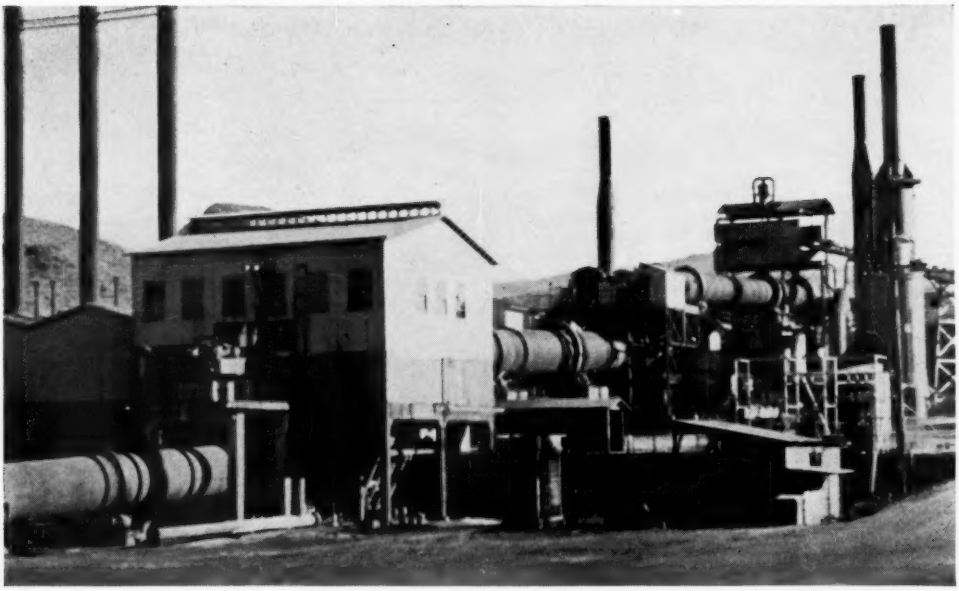


Photo By Russell Waters

All Mechanical Equipment 100% Texaco-Lubricated

This company uses Texaco Lubricants exclusively on all its mechanical equipment—has done so for years. Results are smooth, trouble-free performance even where conditions are severe . . . long life for parts . . . minimum maintenance costs. Here are some of the Texaco Lubricants used and the reasons why:

For open gears: *Texaco Crater X Fluid.* It clings to teeth, gives long-lasting protection, increases gear life. Easy to apply.

For enclosed reduction gears and bearings: *Texaco Meropa Lubricant.* It has high EP properties, resists oxidation, is non-foaming, non-corrosive.

For heavy duty bearings (oil lubricated): *Texaco Regal Oil R&O.* It has high oxidation resistance, prevents rust, wards off wear.

For heavy duty bearings (grease lubricated): *Texaco Marfak Heavy Duty.* It stays in the bearings, seals out dirt and moisture, guards against wear and rust.

Let a Texaco Lubrication Engineer help you get more efficient performance from *your* equipment. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

REG. T.M.

TEXACO Lubricants and Fuels

FOR ALL CONTRACTORS' EQUIPMENT

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by
The Texas Company, 135 East 42nd Street, New York 17, N.Y.
Copyright 1957 by The Texas Company
Copyright under International Copyright Convention. All Rights Reserved under Pan-American Copyright Convention.

A. C. Long, Chairman of the Board of Directors; J. W. Foley, President; C. B. Barrett, E. R. Filley, T. A. Mangelsdorf, J. T. Wood, Jr., Senior Vice Presidents; S. C. Bartlett, J. B. Christian, S. T. Crossland, F. M. Dawson, H. T. Dodge, Oscar John Dorwin, Robert Fisher, F. H. Holmes, L. C. Kemp, Jr., A. N. Lilley, J. H. Pipkin, J. H. Ramblin, Jr., J. S. Worden, Vice-Presidents; Wallace E. Avery, Secretary; E. C. Breeding, Comptroller.

Vol. XLIII October, 1957 No. 10

Change of Address: In reporting change of address kindly give both old and new addresses.
"The contents of 'LUBRICATION' are copyrighted and cannot be reprinted by other publications without written approval and then only provided the article is quoted exactly and credit given to THE TEXAS COMPANY."

CEMENT MILL LUBRICATION

THE HISTORY of cement manufacture goes back hundreds of years B.C. When man first started to make buildings, walls or fortresses out of stone, there was a need for a cementing material that would hold stones together.

Various materials such as clay, lime and gypsum, and blends of lime and volcanic ash were used with varying degrees of success. In fact, many of the ancient Roman buildings have stood up for centuries and are still standing.

The art of making cement that would harden under water was known to the ancient Romans but was lost for several centuries. However, the secret was re-discovered by an English engineer, John Smeaton, around 1758. He developed a cement made by burning lime and clay and used it for building a light house where much of the construction was under water.

Joseph Aspdin, a stone mason in England, was granted a patent in 1824 for a "hydraulic" cement which would harden under water. He called it "portland" cement because it resembled the color of stone which was quarried in the Island of Portland near the British Coast. Although hydraulic cement had been made before, Aspdin introduced careful control of ingredients, burning and then regrinding the clinker.

During the early 1880's there was considerable demand in this country for hydraulic cement for construction of water ways, including the Erie Canal. In 1870 the first portland cement was manufactured in this country near Allentown, Pennsylvania and cement manufacture is still an important industry in that area.

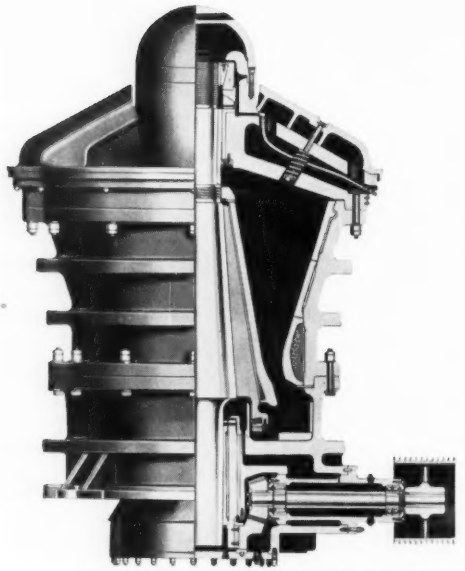
During the great expansion in American industry which has taken place in the last 80 years, there has been a gradual growth of the cement industry. Today we produce over 300 million barrels per year, more than double the production of any other country.

There are now over 175 portland cement mills in this country and Canada. Plants are located in 37 states and most of the cement is used in areas not too far distant from the point of manufacture because of the high cost of long-distance shipment.

Concrete, which is a blend of cement, sand, aggregate and water in definite proportions, plays a most important part in our present expanding economy. It is indispensable in the construction of some buildings and bridges and is also used in walks, airports, marine installations, streets and highways.

COMPOSITION OF CEMENT

Raw ingredients used in cement manufacture consist chiefly of calcareous materials (containing calcium carbonate) such as limestone, chalk or shells, combined with argillaceous materials (clay-like) such as shale and clay. Other materials such as sand and iron ore are often added when required to give the proper formulation.



Courtesy of Allis Chalmers Manufacturing Co.

Figure 1 — "Superior" Gyratory Crusher Used for Primary and Secondary Reduction of Cement Rock.

These materials in definite proportions are crushed and ground to the fineness of flour so that approximately 90% will pass a 200 mesh screen.

The blend is then roasted to incandescence, just short of the fusion point, in a rotating continuous kiln for several hours at a temperature near 2700°F. Certain chemical reactions take place and the resulting clinker is harder than any of the original ingredients. Water and carbon dioxide are removed during the process. The final cement which includes clinker plus a small amount of gypsum ($CaSO_4$) has the following approximate proportions (calculated as oxides):

	Avg. %
Calcium Oxide (CaO)	64.5
Silicon Dioxide (SiO_2)	23.0
Aluminum Oxide (Al_2O_3)	6.5
Iron Oxide (Fe_2O_3)	2.5
Magnesium Oxide (MgO)	2.0
Sulfur Trioxide (SO_3)	1.5

The calcium, aluminum, iron and silicon in the clinker are believed to be combined as follows:

Di calcium silicate — $2\ CaO \cdot SiO_2$
Tri calcium silicate — $3\ CaO \cdot SiO_2$
Tri calcium aluminate — $3\ CaO \cdot Al_2O_3$
Tetra calcium aluminoferrite — $4\ CaO \cdot Al_2O_3 \cdot Fe_2O_3$

When water is applied, these ingredients react and affect the concrete in various ways:

Di calcium silicate has a slower reaction and gives later strength to the concrete.

Tri calcium silicate also has a fast reaction and provides early strength.

Tri calcium aluminate develops considerable heat and has a tendency to set quickly.

The chemical reaction in a concrete mixture continues slowly for years with the hardness and strength increasing gradually.

TYPES OF CEMENT

The American Society for Testing Materials recognizes five types of portland cement as follows:

Type I—For use in general concrete construction when the special properties specified for types II, III, IV, and V are not required.

Type II—For use in general concrete construction exposed to moderate sulfate action or where moderate heat of hydration is required (such as in moderately heavy construction).

Type III—For use when high early strength is required.

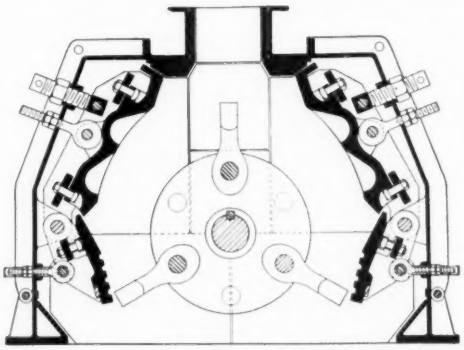
Type IV—For use when a low heat of hydration is required (such as in heavy dam projects).

Type V—For use when high sulfate resistance is required (such as in concrete exposed to alkali or sewage).

ADDITIVES IN CEMENT

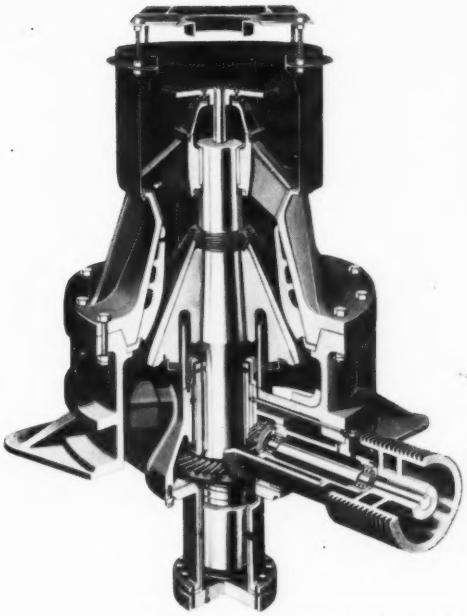
The American Society For Testing Materials defines portland cement as follows:

"Portland cement is the product obtained by pulverizing clinker consisting essentially of hydraulic calcium silicates to which no additions have been



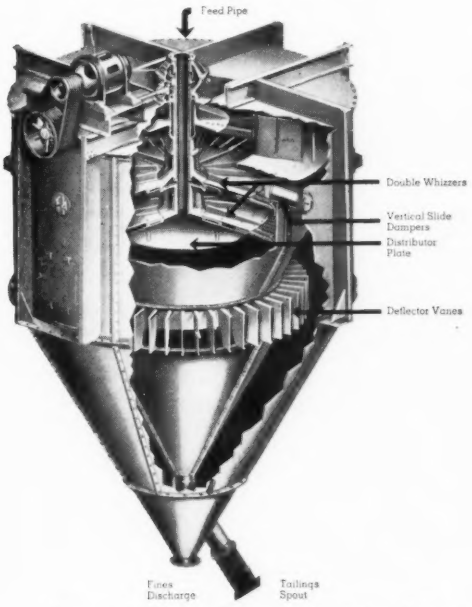
Courtesy of Pennsylvania Crusher Division, Bath Iron Works Corporation

Figure 2 — Sketch of "Reversible Impactor" Used for Secondary Reduction of Cement Rock.



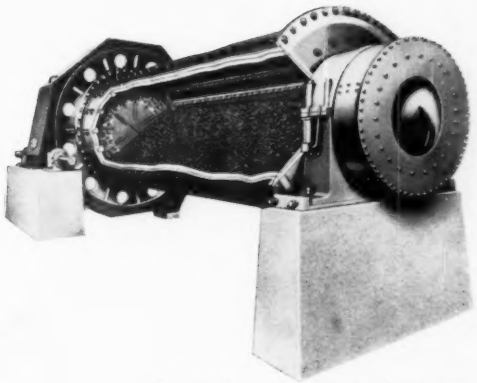
Courtesy of Allis Chalmers Manufacturing Co.

Figure 3 — "Hydrocone" Crusher Used for Secondary and Tertiary Reduction of Cement Rock.



Courtesy of Combustion Engineering Inc., Raymond Division

Figure 4 — "Double Whizzer" Mechanical Separator Used for Separating Fine and Coarse Cement Particles.



Courtesy of Allis Chalmers Manufacturing Co.

Figure 5 — Ballpeb Grinding Mill Used for Secondary Grinding to Produce Finished Cement.

made subsequent to calcination other than water and/or untreated calcium sulfate, except that additions not to exceed 1.0% of other materials may be interground with the clinker at the option of the manufacturer, provided such materials in the amounts indicated have been shown to be not harmful by tests carried out or reviewed by Committee C-1 on Cement."

The above definition recognizes the use of additives in cement.

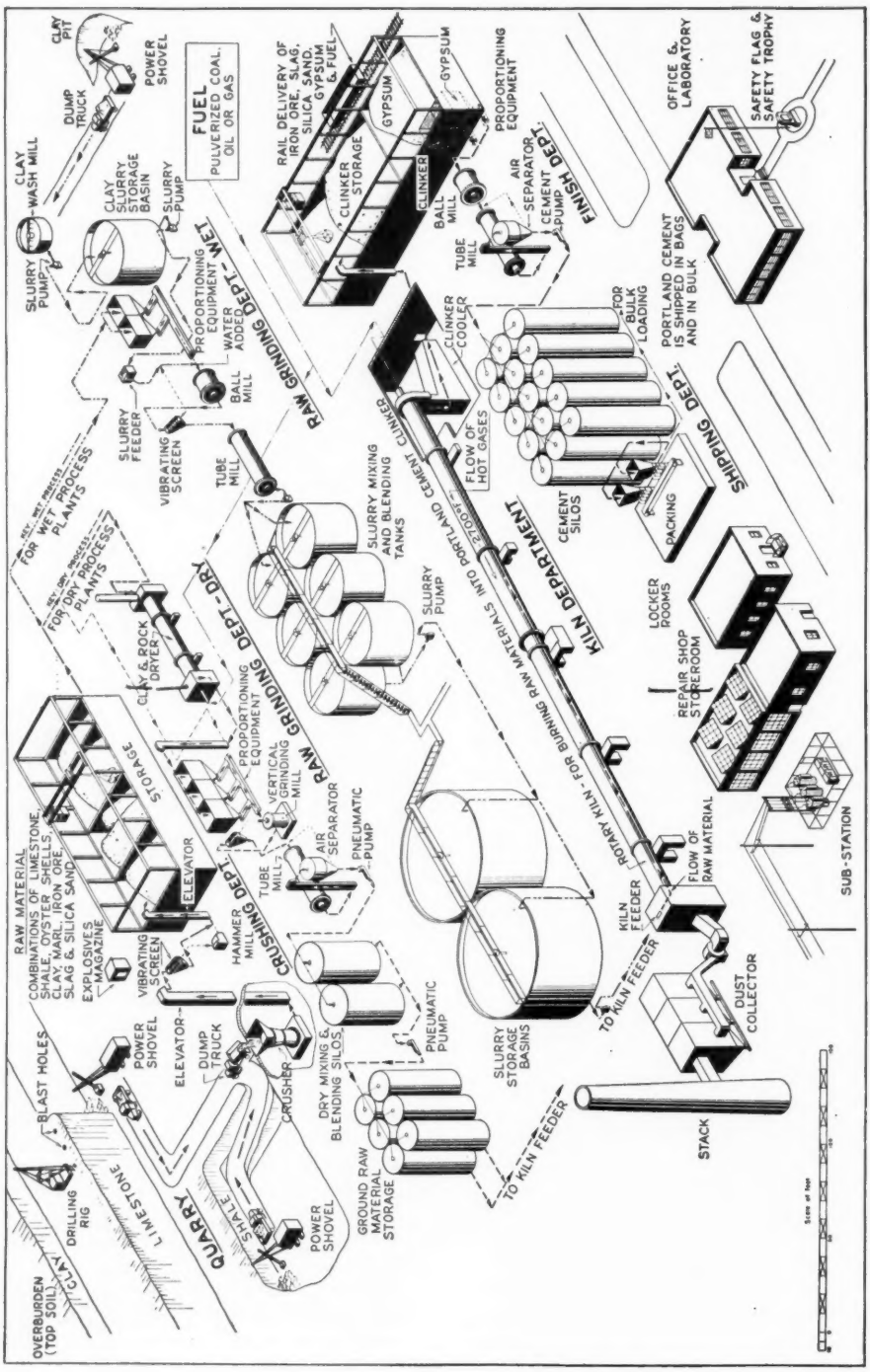
It has been found by careful research work that the addition of small amounts of certain materials will provide remarkable improvements in certain characteristics. These additives enhance greatly the usefulness of concrete; the amounts must be very carefully regulated, however, so that other characteristics, such as compressive strength, flexural strength and durability, will not be lowered. A few of the materials which are added to cement during manufacture are given below:

Air Entraining Agents

Very small amounts (approximately 0.03% by weight) of various materials such as tallow, mineral oil, soluble oil, soap-like resins or fatty materials are added to the clinker before grinding. In some cases they are added to the mix just prior to concrete manufacture.

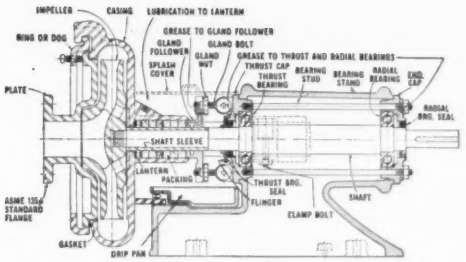
These materials produce millions of tiny bubbles throughout the concrete and the air content is increased from 3 to 6% above the normal content. Air entrainment has several advantages:

1. It minimizes scaling and cracking of concrete surfaces during cycles of freezing and thawing and also cycles of wet and dry conditions.
2. The small air chambers relieve internal pressure by providing expansion voids for freezing water.



Courtesy of Portland Cement Association

Figure 6 — Flow Chart of Manufacture of Portland Cement.



Courtesy of Nagle Pumps, Inc.

Figure 7 — Sketch of Horizontal Shaft Slurry Pump.

3. The concrete is highly resistant to the deteriorating action of calcium chloride, sodium chloride or other chemicals used to thaw ice on pavements.

Air entrained concrete has become widely accepted in industrial construction and most of the state and federal construction agencies specify it for concrete roads, bridges and other structures.

Grinding Aids

Incorporation of a very small amount of grinding aid (0.03 to 0.05% by weight) into the clinker before grinding has the beneficial effect of keeping the steel balls in the ball and tube mills free from a coating of cement. In some cases this has resulted in an improvement in grinding efficiency. One such material is reported to consist of a blend of triethanol-amine, sodium soaps of lignin and rosin and a small amount of fatty acid.

Water-proofing Additives

Small amounts of calcium stearate powder are sometimes added to clinker before grinding to provide water proofing to the bagged cement in warehouses. This prevents undue hardening from absorption of atmospheric moisture during storage.

Quick-Setting Additive

Quick-Setting Additive consisting of a small amount of calcium chloride is often added to concrete when it is mixed in winter. The chief purpose is to prevent freezing of concrete. This type of additive differs from the above in that it is added to *concrete mix* and not to cement during manufacture.

MANUFACTURING PROCESSES

Cement is manufactured by either the wet or the dry process. In the wet process, water is mixed with the pulverized ingredients, and a thick slurry is formed. This method has several advantages:

1. Presence of dust in the mill is greatly reduced.
2. The wet method is preferred where there would be an advantage in blending raw materials.

In the dry process, the cement ingredients are conveyed from one location to another by means of cement pumps or conveyors. Other than slurry handling and flotation, the dry method employs the same type of equipment as the wet method.

In the following pages, the wet manufacturing procedure is outlined in chronological order from raw material to the finished product. Information is also provided on lubrication of the major pieces of equipment.

Cement Mill Machinery

Portland cement manufacture requires the processing of immense quantities of heavy rock and other ingredients so there will be a continuous flow of materials through the plant to produce the finished product.

Most of the machinery is of very heavy construction, and large amounts of fuel, electricity, and lubricants are required for its operation. The lubricants must be of high quality and capable of handling heavy duty loads and of providing adequate lubrication often under very adverse conditions. Precautions must be taken to protect lubricants from dust which is always present. Water and high heat conditions also present hazards to lubrication.

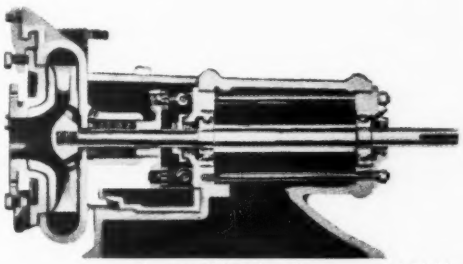
Quarry

In the average cement plant, the quarry operations may be situated from one to several miles away. In the quarry several types of equipment are used:

Well Drilling Machines

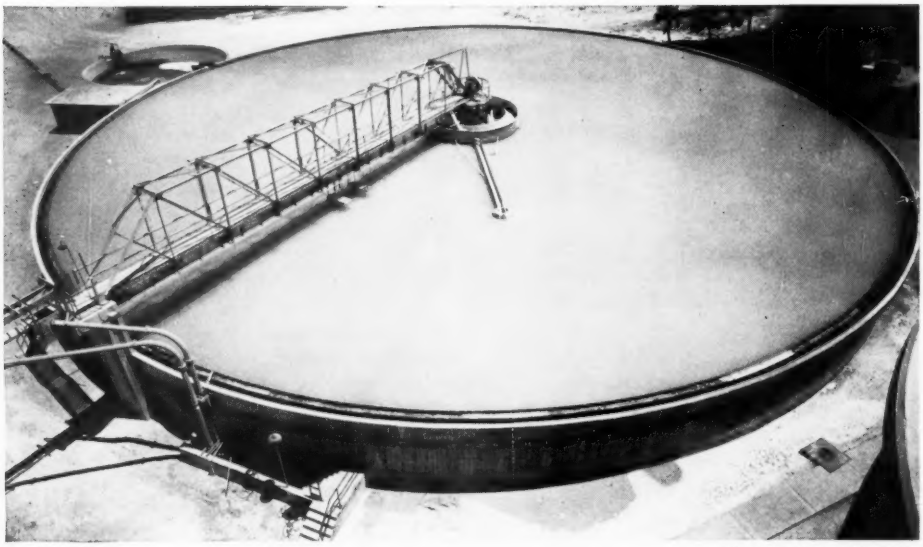
Vertical holes usually 4" to 6" in diameter are drilled in the rock and are charged with explosives for blasting off the face of the quarry. The older type drills employ water to remove the drilling dust but with the newer rotary drills, dust is blown out with air. Holes are often 100 to 150 feet deep.

Drilling machines may be powered by electric motors which are lubricated by ball and roller bearing grease. Other machines may be operated by gaso-

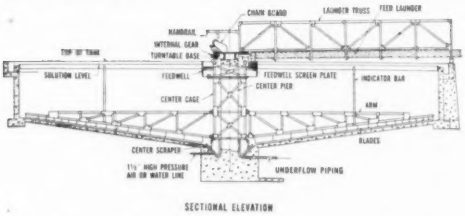


Courtesy of American Manganese Steel Division of American Brake Shoe Company

Figure 8 — Cutaway Sketch of Horizontal Shaft Slurry Pump.



Courtesy of Dorr-Oliver, Inc.



SECTIONAL ELEVATION

Figure 9 — View of 190 ft. "Torq" Thickener Used for Dewatering Raw Cement Rock.

line engines which are lubricated with a good motor oil, usually SAE 30 grade.

Electric and Diesel Shovels

Blasted rock is loaded by shovel into small rail cars or trucks for transportation to the crushers. The electric shovels are powered by electric motors which are lubricated with ball and roller bearing grease. Heavy residual type lubricants are usually satisfactory for the gear assemblies.

Diesel shovels are powered by diesel engines, which are normally lubricated with heavy duty motor oils.

Pumps

Surface and seepage water collects in pockets on the quarry floor, and pumps are required for removal. Centrifugal pumps with ring oil type bearings are lubricated with low viscosity mineral oil. Grease type bearings usually require No. 2 NLGI grade ball and roller bearing grease.

Railway Cars or Diesel Trucks

Diesel operated narrow gauge trains, or diesel trucks are used to transport rock to the crushers.

Diesel engines are lubricated with heavy duty motor oil. Journal bearings of railway cars are usually waste packed and lubricated with car oil.

Primary Crushing

Rock is received at the crusher in varying sizes, some pieces as long as 3 or 4 feet. This rock must eventually be reduced to the size of fine powder. The primary crushing is usually performed by roll, jaw or gyratory crushers which reduce the size to 4 inches or less. Pressures in these mechanisms are tremendous and considerable heat is developed.

Roll Crusher

In this type of machine, rock is crushed by the action of knobs on a large rotating roll beating against a stationary anvil. The crushed rock drops down into a hopper which feeds onto a conveyor which carries the rock to the second crushing operation. The sleeve type bearings which support the large roll are usually lubricated with grease of No. 2 or No. 3 NLGI consistency applied through a pressure system.

Jaw Crusher

The crushing in this type of machine is performed by a heavy steel casting or pitman which oscillates and provides the crushing effect. The

crushed rock falls through the bottom of the crusher onto a conveyor which carries it to a storage bin or to another crushing machine. The bearing of the pitman is usually water cooled to remove heat and lubricated with No. 1 or No. 2 NLGI grade grease.

Gyratory Crusher

In this machine the crusher head rotates with an eccentric rolling motion. The rock is crushed against the outside shell and falls through the bottom to conveyors for further handling.

The crusher is driven by bevel gear and pinion through a pinion shaft. Power can be furnished by engine or electric motor through a V belt drive.

The bearings as well as gears in crushers are subjected to very heavy loads, extremes of temperature and a great deal of dust and grit. Lubrication is usually handled through a circulating system consisting of a pump and sump tank (50 to 250 gallons capacity) which is equipped with a filter.

Oil is delivered by gear pump from the tank through filters and then through the cooler into the crusher. Hot used oil then returns to the tank. Temperature of the oil returning from the crusher is usually held between 100°F. and 130°F. A mild EP lubricant with viscosity of 300-500 seconds at 100°F. is usually specified for this use.

Scalping or Vibrating Screens

Rock from the primary crushers is processed through scalping or vibrating screens (approximately 1" mesh). The finer material is conveyed to the rock storage while the material above 1" size goes on to the secondary crushing operation.

Antifriction bearings on these screens are usually lubricated with No. 2 NLGI grade ball and roller bearing grease applied by pressure gun.

Secondary Crushing

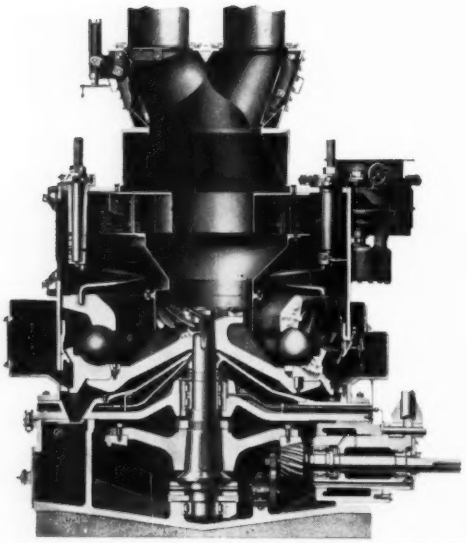
The coarser sized rock which has passed through the primary crushing stage is further reduced in size in the secondary crushing operation. Several types of secondary crushers are available including hammer mills, impactors and cone type crushers.

Hammer Mill

The larger pieces from primary crushing are delivered to the hammer mill for additional reduction. In the first zone of this mill, rotating hammers

Courtesy of Eimco Corporation

Figure 10 — Disc Filters Used in Removing Water from Cement Slurry.



Courtesy of Babcock & Wilcox Company

Figure 11 — Coal Pulverizer Used to Produce Powdered Coal before Injection into Kiln.

beat the rock feed against large anvils. The material ricochets and is struck again until it is shattered.

In the second zone the hammers operate at closer clearance, and the rock is reduced still further in size, finally escaping between bars at the bottom.

Some of the newer mills have identical crushing capacity on each side of the mill, and the rotors are reversible. This is reported to give double mill life.

The working parts of crushers undergo terrific wear and the toughest steel must be used. The rotor bearings on these mills are usually antifriction roller type and are carefully housed to exclude abrasives.

Due to the comparatively high speed of these machines, oil is used to lubricate the rotor roller bearings. Oils with viscosity at 100°F. (SU) of 150-500 seconds are satisfactory in various units. Static oil lubrication is used on the smaller machines, and a circulating system is used on the larger units.

Reversible Impactor

Impactors have somewhat similar construction to the hammer mills. They are equipped, however, with extra rugged breaker blocks, and in addition to being ground by the hammers, rock is also shattered by being impacted against the blocks.

Lubrication of the rotor bearings is similar to that on hammer mills.

Hydraulic Cone Crusher

In this type crusher the mainshaft which includes the crushing cone can be raised or lowered hydraulically by means of a hydraulic jack. Oil pumped into or out of the jack raises or lowers the entire assembly and changes the crusher setting. This controls the size of the crushed rock and also compensates for wear on the mantle and concave crushing block.

In order to supply adequate lubrication to all working parts, three lubrication systems are employed:

1. Automatic circulating system lubricates eccentric, step bearing and gear with a mild EP Lubricant (viscosity 300 secs. (SU) at 100°F.)
2. Bath lubrication with a garter seal is used with the spider bearing, and an SAE 250 EP Gear Lubricant is usually satisfactory.
3. Bath lubrication is also employed with the countershaft bearing. The same mild EP lubricant used in the circulating system is also used here.

Primary Grinding

Pulverized rock from the primary crushing is removed from rock storage and blended with other ingredients by means of weighing and feeding machines. This blended material is conveyed to the primary ball or rod mill.

Primary Ball or Rod Mill

In this mill the blend is thoroughly mixed with carefully measured amounts of water, usually 80% water and 20% solids. A grinding mill usually consists of a cylinder containing 43 to 45% by volume of steel balls or steel rods, revolving horizontally on its axis. The steel ball content by volume is carefully mantained. As the cylinder turns, the balls or rods cascade down on the material reducing it to a very fine powder which is removed in the form of a slurry at the discharge end.

For primary grinding the balls or rods are usually 2″ to 4″ diameter. For secondary grinding sizes range from ¾″ to 2″ diameter. The smaller sizes produce finer material. Rods are about 10″ long.

This same type mill is also used for dry grinding and in this process the dry powder moves gradually along to the discharge end.

The wet method, where it can be used, is generally preferred because of elimination of dust and the need for dust collecting equipment.

Because of the excessive weight of these mills, the babbitted or bronze type trunnion bearings are usually of very sturdy construction. Bearings on larger mills are oil lubricated with an SAE 90 gear oil but soda base block type grease is used in smaller units.

The mill ring gear is usually protected by a guard to safeguard personnel and to keep out extraneous material. Best type of lubricant for the ring gear is an adhesive residual gear oil with mild EP characteristics.

Pinion shafts are usually mounted on antifriction

type bearings. Either soda soap grease of No. 2 NLGI grade consistency or mineral oil with a viscosity (SU) of 100 seconds at operating temperature are used.

Rake Classifier

In the wet process of cement manufacture the slurry from primary grinding is processed through a machine known as a classifier. This consists of a series of rakes operating on an inclined plane in a tank. The rakes propel the material being processed, and during the operation the finer particles in the slurry are separated from the coarser. The coarse material is returned for further pulverizing.

Secondary Grinding

The slurry from primary grinding is usually processed again through ball or rod mills similar to those used in primary grinding. The purpose is to get the rock particles fine enough for further processing.

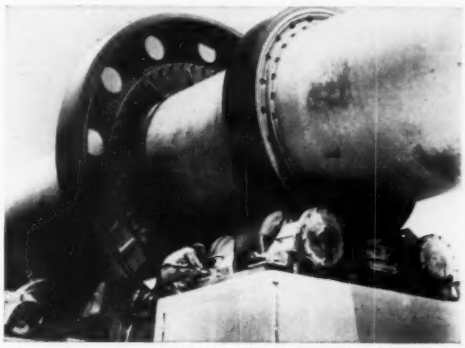
Bowl Classifier

The product which is discharged from the secondary ball mills is delivered to the bowl classifier, which consists of a large tank with slow agitation. The larger particles are delivered back to the ball mills, where they are reground to the proper size for the next stage.

The bowl classifier discharges the finished product to a sump pump which conveys the material to a thickener where water content is reduced from 80% to approximately 65%.

Slurry Pumps

Slurry pumps deliver the product from the thickener to the slurry receiving tanks near the cell house. The pumps are very ruggedly built and are constructed with manganese steel or other alloys which withstand the constant abrasion of materials being

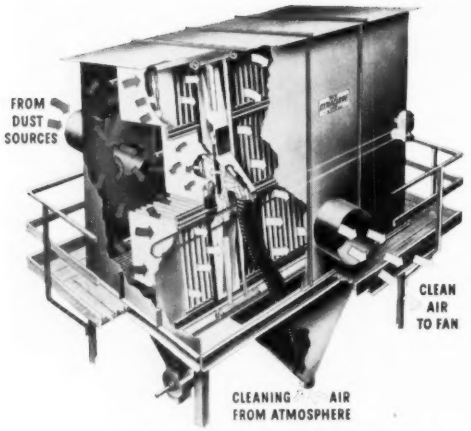


Courtesy of Allis Chalmers Manufacturing Co.

Figure 12 — Rotary Kiln Showing Riding Ring Carrying Rollers and Drive Mechanism.

Courtesy of Allis Chalmers Manufacturing Co.

Figure 13 — Rotary Kilns.



Courtesy of The W. W. Sly Manufacturing Co.

Figure 14 — "Dynaclone" Dust Collector for Cleaning Dust Laden Air.

handled. They are equipped with antifriction bearings which are usually lubricated with a No. 2 NLGI grade roller bearing grease.

Centrifuges

Part of the slurry is processed through large centrifuges which provide additional separation of heavier particles. The heavy portion in the form of fairly dry slurry is known as "cake" and is drawn off the centrifuge by screw conveyor incorporated in the machine. The main purpose of the centrifuge is to increase the desirable lime and silica content and to lower the amount of undesirable alumina and alkalies. The cake is mixed again with water so that it can be pumped to the blending tanks. Main bearings (ball or roller) are usually lubricated with a circulating oil with 600 viscosity SU at 100°F. Smaller machines are bath lubricated and larger ones are lubricated by means of a circulating system.

Flotation Cells

The lighter portion from the centrifuges is delivered to the cell house where it is treated with various chemicals such as alcohols, tall oil, dispersing or wetting agents and diesel fuel oil. By selective flotation the quality of the slurry is up-graded considerably. Twenty-five per cent of the portion processed by flotation is normally rejected. This contains mica and graphitic carbon. The remaining high quality material is eventually delivered to the thickener for concentration.

The success of the flotation system depends greatly on the use and handling of a suitable reagent. It must be delivered at a constant and definite rate. Reagent feeders are used for this purpose.

The centrifuging and flotation processes are used in mills where the limestone raw material has calcium carbonate content below that normally required for portland cement. These processes benefit sufficiently to give the proper calcium carbonate content.

The flotation machine is equipped with antifriction bearings which carry the vertical axle. Bearings are lubricated with a No. 2 NLGI grade ball and roller bearing type grease.

Thickeners

After the cement slurry has been processed to its desired quality, it is pumped to a thickener to remove as much water as possible before the blending operation. Another similar thickener handles slurry from the raw grinding operation.

The thickener consists of a concrete vat or tank several feet deep and with a diameter often 200 ft. or more. The bottom slopes gently toward the center.

The finely divided rock has a tendency to settle and the clear water comes to the top. A slowly revolving rake sweeps the settled solids toward the discharge opening in the tank bottom and clear water overflows continuously around the whole periphery of the top of the tank.

There is a continuous flow of slurry into the vat and a continuous segregation of heavy concentrate from water. The concentrate is pumped to concrete blending silos for further processing.

The rake is supported by a central column to which the drive mechanism including large diameter worm gear, drive unit and gear train are attached.

Worm gears and reduction gears are lubricated with mild EP gear oils. For open gears, heavy residual gear lubricants are recommended.

Rotary Vacuum Filters

After blending, slurry from storage silos is pumped into troughs on the side of the rotary vacuum filter which is usually located on the top floor of the kiln house. The filter contains a battery of 5 to 12 vacuum disks and each disk contains several removable segments covered with cloth. The disks rotate slowly picking up a layer of slurry which forms a cake of solids on the side.

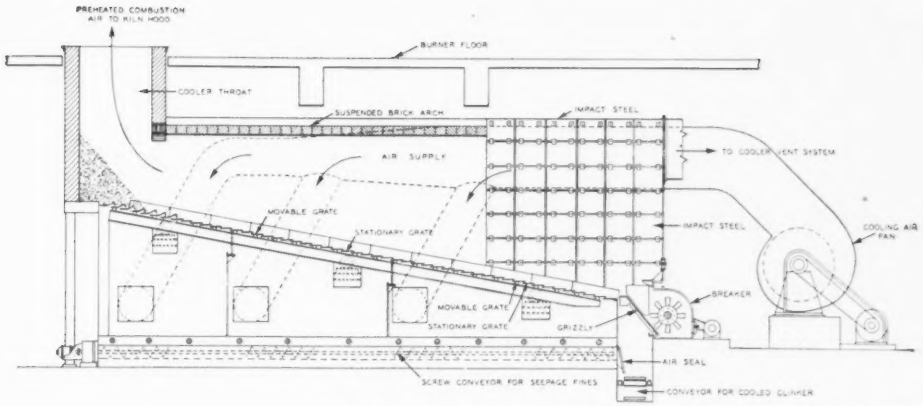
As the disk rotates, vacuum removes water and the cake becomes firmer; water content is reduced from approximately 41 to 21 percent. As it approaches the discharge point, vacuum is shut off from each disk and low pressure air is applied. This releases the semi-dry cake from the cloth segment and it collects in a hopper. The disk continues its rotation down into the slurry and picks up another coating.

Each battery of disks is mounted on a hollow axle carried on roller bearings, and lubricated with a No. 2 or No. 3 NLGI grade roller bearing grease.

Semi-dry cake is delivered from the hopper to the kiln feed pipe, by a pug mill or screw conveyor.

Kiln

Large cement kilns 10 ft. or more in diameter and



Courtesy of Fuller Company, Subsidiary of General American Transportation Corporation

Figure 15 — Drawing of Inclined Grate Clinker Cooler Equipped with Clinker Breaker.

approximately 200 to 400 ft. long are used to reduce the slurry to clinker.

They are installed in a horizontal position but with a slight slope of about ½ inch per foot of length and they rotate at about 1 RPM.

The kilns are heated by gas, oil or pulverized coal and heat is applied at the discharge or lower end. A temperature of about 2700°F. is required for cement manufacture.

The slurry or filter cake is fed into the upper or cooler end of the kiln. Due to the slope and rotation, the cake disintegrates and moves slowly along. The water is usually removed in the first 80 ft. and carbon dioxide comes off at the point where the temperature reaches approximately 1600°F. Several other chemical changes also take place.

It requires 3 or 4 hours for the material to travel the length of the kiln and in that time the clinker has been heated to a red heat, just short of its fusing point. When the reaction is complete, the clinker pellets are ½ to 2 inches in diameter and after they cool, they are hard and brittle. The red hot clinker drops into a hopper at the end of the kiln.

Each kiln is equipped with 4 or more girth tires around the circumference. Each tire is supported by two rollers making a total of 8 or more which support the whole weight of the kiln. Each roller has two trunnion bearings.

In addition to these rollers, there is a pair of horizontal thrust rollers which bear on two edges of one of the girth tires. These rollers help to prevent the kiln from moving endwise from its fixed position.

All these bearings are usually lubricated from a circulating system by means of a pressure oil system through individual sight cups. The oil from the bearings drains into a sump and is pumped through a filtering system and returned again to the bearings. High melting point block greases are also used in some units to lubricate the plain bronze roll bearings.

Power for rotating the kilns is supplied by a motor operating through a speed reducer and a pinion gear which turns the large girth gear slowly. This pinion gear is usually lubricated from a reservoir into which the gear dips or by means of an idler gear which dips into the lubricant transferring it to the girth gear. Heavy cylinder stocks or EP type gear lubricants are usually used as lubricant.

Coal Pulverizers

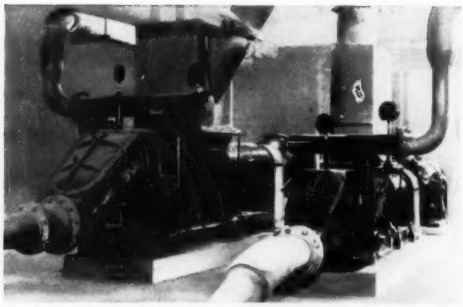
In those plants using coal as fuel, a pulverizing unit is operated with each kiln. Coal is crushed and ground by steel rollers or balls rotating against the face of a steel drum. Various sized pulverizers have capacities varying from 1 to 25 tons per hour. The coal dust, mostly finer than 200 mesh, is mixed with the required amount of hot air from the clinker cooler and is blown through burner nozzles into the kiln where it ignites like gas. (When starting up, the initial heat is supplied by an oil burner.)

Clinker Coolers

The hot clinker dropping from the end of the kiln is conveyed slowly on inclined grates through a chamber where temperature of the clinker is lowered from 2500°F. to 100°F. The clinker is cooled or quenched by air driven by large fans. Heat is recovered by using this heated air for combustion in the kiln. The cooled clinker is then conveyed by bucket, belt or screw to clinker storage bins. The various parts of the clinker coolers are lubricated through grease cups or pressure fittings using greases of NLGI No. 1 or No. 3 consistency.

Dust Collecting System

In handling clinker there is quite a bit of fine dust involved. In order to reclaim this dust and keep it



Courtesy of Fuller Company, Subsidiary of General American Transportation Corporation

Figure 16 — "Fuller-Kinyon" Stationary Pumps for Conveying Dry Cement Dust.

from contaminating the surrounding area, a dust collecting system is installed. This includes fans and cyclone separators.

Clinker Grinding

Clinker from the storage bins is delivered to hoppers connected with weighing machines which deliver the clinker by conveyors at a predetermined rate to primary ball mills or bowl mills. Gypsum in definite proportion (2 to 4%) is usually added to the clinker before it enters the primary pulverizing mills. The purpose of this material is to help control the setting time of concrete.

The partially pulverized clinker is then conveyed to the secondary grinding mills consisting of ballpeb mills or tube mills where the cement is ground to finer size.

From these mills the pulverized material is often processed through separators which utilize air flow to separate the coarser particles. The coarse material is returned to the ball mills where it is recycled until it has the required fineness. The fine cement, 98% of which will pass through a 200 mesh screen, represents finished material and it is delivered by screw conveyors to the hoppers of the cement pumps.

Cement Pumps

Finished cement enters the pump by gravity through a hopper and is advanced through a cylindrical barrel by means of an impeller screw. It is discharged into a mixing chamber where a series of compressed air jets give it fluid characteristics. The air jet pressure conveys the cement through pipes to cement storage silos. The air is supplied by a low pressure air compressor connected to the pump.

Pump bearings are lubricated with ball and roller bearing type grease. Very special oils not easily described are recommended for the compressors.

White Cement

Cement manufactured with the average dark colored limestone as the basic ingredient usually produces a grey colored product. This type is normally used for highway and other construction.

There is also considerable requirement for a white cement for use in cement paint manufacture, terrazzo work, safety markers on highways, plaster and for ornamental work. To produce this type, light colored calcium carbonate minerals along with high grade argillaceous material having low iron content must be used.

In plants where both grey and white cement are manufactured, it is necessary to have completely separate sets of equipment including kilns and storage bins for each type.

Packing Machines

Finished cement from the storage silos is conveyed to packing machines where paper bags are filled. Each bag has a 94 pound capacity and contains 1 cubic foot. Production is usually calculated in terms of barrels and each barrel consists of 4 bags or 376 pounds.

Cement is also drawn from the storage silos into special cement cars for bulk rail shipment.

Steam and Electric Power Generation

In order to reclaim part of the waste heat from the kilns, many cement mills are equipped with waste heat boilers. Sufficient heat is absorbed from the waste gases to provide steam and a large part of the electric power needed for the plant.

Steam turbine and generator units are usually lubricated from a common circulating system using a low viscosity turbine grade oil.

SUMMARY

In the cement industry, due to the nature of the work involved, most of the machinery is of very heavy and rugged construction. Lubricants for these machines must be of high quality and capable of withstanding heavy loads and of providing adequate lubrication under very adverse conditions.

The continual presence of dust, water and high heat conditions present hazards to lubrication and careful precautions must be taken to choose the proper lubricant for each machine and to protect it from contamination.

In the next few years the cement industry is looking forward to considerable expansion of business due to heavy building construction, proposed Federal highway building program, and other large projects such as the St. Lawrence Seaway. Many plants are enlarging their facilities in anticipation of this increased demand for cement.

The petroleum industry through its constant research will continue to provide superior lubricants for these rugged machines operating under rugged conditions.

Printed in U. S. A. by
Salley & Collins, Inc.
305 East 45th Street
New York 17, N. Y.

HOW TO KEEP PRODUCTION IN HIGH

High production rates depend on getting top performance from *all* your equipment *all the time*. And the surest and least expensive way to get efficient, dependable operation is through scheduled lubrication with lubricants specially developed for your equipment.

For example, you'll get better chassis protection with a lubricant that seals itself in the bearings . . . *Texaco Marfak*. This special chassis lube gives longer lasting protection against rust and wear, seals out dust and dirt. Its tough film stays put under repeated heavy impacts.

For a wheel bearing lubricant that stays in the bearings and off the brakes . . . use *Texaco Marfak Heavy Duty*. It's an all-season lubricant that permits repacking on an extended mileage basis.

If you prefer just *one* lubricant for chassis, wheel bearing, water pump and other grease lubrication . . . use multi-purpose *Texaco Marfak Heavy Duty Special 2*. This lithium-base grease pumps easily, resists water washout and stays put in the toughest service.

And to give all kinds of rolls maximum protection from rust and wear . . . use *Texaco Track Roll Lubricant*.

Why not find out exactly how a few Texaco products can keep your equipment running efficiently *all the time*. Call the nearest of more than 2,000 Texaco Distributing Plants in the 48 States or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

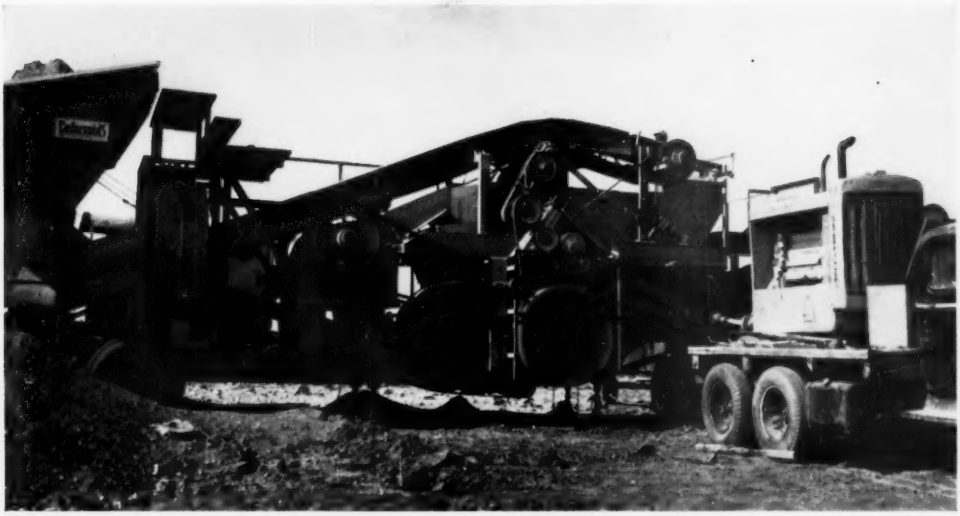
MORE THAN 700 MILLION POUNDS OF TEXACO MARFAK HAVE BEEN SOLD

TEXACO

REG. T.M.

TEXACO Lubricants and Fuels

FOR ALL CONTRACTORS' EQUIPMENT



"We recommend Texaco to all our customers"

...Boyd Titsworth, Field Service Engineer, Iowa Manufacturing Company, Cedar Rapids, Iowa

"We have been using Texaco for more than twenty years," says Mr. Titsworth. "Instruction plates on all 'Cedarapids' crushers, screens, driers, hammermills and other heavy duty equipment recommend Texaco exclusively.

"*Texaco Marfak*, for example, has always done an outstandingly fine job. Our long experience shows it to be the best lubricant for the heavy duty service, shock loads and high temperatures our equipment often meets on the job. That's why every piece of 'Cedarapids' equipment is *Marfak*-lubricated when it leaves our plant."

Mr. Titsworth expresses the findings of contractors everywhere – that *Texaco Marfak* really stays in the bearings and gives the tough, long-lasting protection that heavy duty equipment must have. And that is why –

MORE THAN 700 MILLION POUNDS OF TEXACO MARFAK HAVE BEEN SOLD

Let a Texaco Lubrication Engineer give you full details and develop a Texaco Simplified Lubrication Plan for you. This will enable you to handle *all* major lubrication with *no more than* six Texaco products.

Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THE TEXAS COMPANY • • • DIVISION OFFICES

ATLANTA, GA.....864 W. Peachtree St., N.W.
BOSTON 16, MASS.....20 Providence Street
BUFFALO 5, N. Y.....P.O. Box 368
BUTTE, MONT.....220 North Alaska Street
CHICAGO 4, ILL.....332 So. Michigan Avenue
DALLAS 2, TEX.....311 South Akard Street
DENVER 3, COLO.....1570 Grant Street
HOUSTON 2, TEX.....720 San Jacinto Street
INDIANAPOLIS 1, IND., 3521 E. Michigan Street
LOS ANGELES 15, CAL....929 South Broadway
MINNEAPOLIS 3, MINN....1730 Clitton Place
NEW ORLEANS 16, LA:.....1501 Canal Street
NEW YORK 17, N. Y.....205 East 42nd Street
NORFOLK 2, VA.....3300 E. Princess Anne Rd.
SEATTLE 1, WASH.....1511 Third Avenue

TEXACO

Texaco Petroleum Products are manufactured and distributed in Canada by McColl-Frontenac Oil Company Limited.